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IS 5921-4 (1987): Metal-clad Base Materials for Printed Circuits for Use in Electronic and Telecommunication Equipment, Part 4: Phenolic Cellulose Paper Copper Clad Laminated Sheet of Defined Flammability [LITD 5: Semiconductor and Other Electronic Components and Devices]



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*Indian Standard*

**SPECIFICATION FOR  
METAL-CLAD BASE MATERIALS FOR  
PRINTED CIRCUITS FOR  
USE IN ELECTRONIC AND  
TELECOMMUNICATION EQUIPMENT**

**PART 4 PHENOLIC CELLULOSE PAPER COPPER CLAD  
LAMINATED SHEET OF DEFINED FLAMMABILITY  
( VERTICAL BURNING TEST )**

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**BUREAU OF INDIAN STANDARDS**  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# *Indian Standard*

## SPECIFICATION FOR METAL-CLAD BASE MATERIALS FOR PRINTED CIRCUITS FOR USE IN ELECTRONIC AND TELECOMMUNICATION EQUIPMENT

### PART 4 PHENOLIC CELLULOSE PAPER COPPER CLAD LAMINATED SHEET OF DEFINED FLAMMABILITY ( VERTICAL BURNING TEST )

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**IS : 5921 ( Part 4 ) - 1987**

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*Indian Standard*  
SPECIFICATION FOR  
METAL-CLAD BASE MATERIALS FOR  
PRINTED CIRCUITS FOR  
USE IN ELECTRONIC AND  
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**PART 4 PHENOLIC CELLULOSE PAPER COPPER CLAD  
LAMINATED SHEET OF DEFINED FLAMMABILITY  
( VERTICAL BURNING TEST )**

**0. F O R E W O R D**

**0.1** This Indian Standard ( Part 4 ) was adopted by the Indian Standards Institution on 19 March 1987, after the draft finalized by the Printed Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

**0.2** This standard ( Part 4 ) is to be used in conjunction with IS : 5921 ( Part 1 )-1983\* which is a necessary adjunct to this standard.

**0.3** While preparing this standard, assistance has been derived from the following:

IEC Document 52 ( Central Office ) 242 Draft — Revision of Publication 249-2: Base Materials for Printed Circuits: Part 2 Specifications; Specification No. 7: Phenolic Cellulose Paper Copper Clad Laminated Sheet of Defined Flammability ( Vertical Burning Test ), International Electrotechnical Commission ( IEC ).

NEMA: Industrial Laminated Thermosetting Products LI-1-1977, National Electrical Manufacturers' Association, USA.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( first revision ).

†Rules for rounding off numerical values ( revised ).

## 1. SCOPE

1.1 This standard ( Part 4 ) specifies the requirements for phenolic cellulose paper copper-clad laminated sheet of defined flammability ( vertical burning test ) for use in printed wiring in telecommunication and allied electronic equipment.

## 2. TERMINOLOGY

2.1 For the purpose of this standard, the terms and definitions as given in IS : 1885 ( Part 6 )-1978\* shall apply.

## 3. MATERIAL AND CONSTRUCTION

3.0 The sheet consists of an insulating base with metal foil bonded to one or both sides.

3.1 **Insulating Base** — The base material shall be phenolic resin bonded cellulose paper laminate. Its flame resistance is defined in terms of flammability requirement specified.

3.2 **Metal Foil** — The base material shall be covered with copper as specified in IS : 10922-1984†.

## 4. MARKING

4.1 The marking shall be in red colour in accordance with 3 of IS : 5921 ( Part 1 )-1983‡. If letters or numbers are used, these shall be upright in the machine direction as shown below:

A	A	A	A	↑	12	12	12
A	A	A	A		12	12	12
A	A	A	A		12	12	12
A	A	A	A	↓	12	12	12
				machine			
				direction			

## 5. TESTS

5.1 The provisions of 4 of IS : 5921 ( Part 1 )-1983‡ shall apply except as modified by 5.1.1. The methods of tests shall be as described in IS : 5921 ( Part 1 )-1983‡.

5.1.1 **Acceptance Tests** — In addition to the tests specified in 4.1.2 of IS : 5921 ( Part 1 )-1983‡, flammability test shall also be carried out

\*Electrotechnical vocabulary: Part 6 Printed circuits ( *first revision* ).

†Specification for copper coil for use in the manufacture of copper-clad base materials.

‡Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( *first revision* ).



as acceptance test. Sampling plans and acceptance levels may be agreed to between the purchaser and the supplier.

**5.1.2 Routine Tests** — The following tests may be carried out as routine tests:

- a) Visual examination, and
- b) Dimension and tolerances.

## 6. ELECTRICAL PROPERTIES

**6.1** The electrical properties shall meet the requirements as given in Table 1.

TABLE 1 ELECTRICAL PROPERTIES

SL No.	PROPERTY	TEST METHOD [ REF TO CL No. OF IS : 5921 ( PART 1 )- 1983* ]	REQUIREMENT
i)	Resistance of foil	5.1	As specified in IS : 10922-1984†
ii)	Surface resistance while in humidity chamber ( optional )	5.2	500 M $\Omega$ , <i>Min</i>
iii)	Surface resistance after recovery	5.2	1 000 M $\Omega$ , <i>Min</i>
iv)	Volume resistivity while in humidity chamber ( optional )	5.2	50 M $\Omega$ m, <i>Min</i>
v)	Volume resistivity after recovery	5.2	500 M $\Omega$ m, <i>Min</i>
vi)	Relative permittivity after damp heat and recovery	5.4	The average value shall not exceed 5.5
vii)	Dielectric dissipation factor after damp heat and recovery	5.4	The average value shall not exceed 0.07
viii)	Surface resistance at 100°C	5.2.4	30 M $\Omega$ , <i>Min</i>
ix)	Volume resistivity at 100°C	5.2.4	15 M $\Omega$ m, <i>Min</i>

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( *first revision* ).

†Specification for copper coil for use in the manufacture of copper-clad base materials.

## 7. NON-ELECTRICAL PROPERTIES OF THE COPPER-CLAD SHEET

### 7.1 Surface Finish of the Copper-Clad Face

7.1.1 The copper-clad face shall be free from blisters, wrinkles, pinholes, deep scratches, pits and resin. Any discolouration or contamination shall be readily removed with a hydrochloric acid solution of density 1.02 g/cm<sup>3</sup> or with a suitable organic solvent. The surface shall be inspected in accordance with 6.2 of IS : 5921 ( Part 1 )-1983\*. The surface finish of the copper-clad face shall be such as not to conceal imperfections.

7.1.2 The surface of the copper foil shall be free from scratches of depth greater than 0.010 mm or 1/5 of the nominal thickness of the copper foil, whichever is the lower.

7.1.3 The total length of scratches of depth greater than 0.005 mm but not greater than 0.010 mm shall not exceed 1 m per square metre of the total area of the sheet under test.

7.1.4 The area of any one or number of pinholes in an area of 0.5 m<sup>2</sup> shall not exceed the area of circle of diameter 0.125 mm.

7.1.5 No sheet shall have more imperfections of the types listed than those permitted by Table 2.

### 7.2 Thickness

7.2.1 The thickness of a sheet, including the metal foil, shall not depart at any point from the nominal thickness by more than the appropriate value given below:

<i>Nominal Thickness</i>	<i>Deviation</i>
mm	mm
0.5	± 0.07
0.7	± 0.09
0.8	± 0.09
1.0	± 0.11
1.2	± 0.12
1.5	± 0.14
1.6	± 0.14
2.0	± 0.15
2.4	± 0.18
3.2	± 0.20

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests. (first revision).

TABLE 2 TYPE, SIZES AND PERMITTED NUMBERS OF IMPERFECTIONS

( Clause 7.1.5 )

SL No.	TYPE	SIZE ( LENGTH, UNLESS OTHERWISE INDICATED )		NUMBER OF IMPERFECTIONS PERMITTED	
		Above	Not Above	In Any Sheet of Area About 1 m <sup>2</sup>	In Any Area of 300 × 300 mm
(1)	(2)	mm (3)	mm (4)	(5)	(6)
i)	Inclusions	— 0.1 0.25	0.1 0.25 —	Any number 30 0	Any number 4 0
ii)	Indentations	— 0.25 1.25  3.0 or width 1.0	0.25 0.15 3.0 or width 1.0 —	Any number 13† 3† 0	Any number 3* 1* 0
iii)	Dump	— 0.1  4.0 or height 0.1	0.1 4.0 or height 0.1 —	Any number 10 0	Any number 2 0
iv)	Wrinkles/ blisters	Of any size	—	0	0

NOTE 1 — For sheets of 1 m<sup>2</sup> or greater, the values of the fifth column apply for any area of 1 m<sup>2</sup>; for the same sheets in any area of 300 × 300 mm, however, the values of the sixth column apply. For sheets smaller than 1 m<sup>2</sup>, the sixth column applies for any area of 300 × 300 mm.

NOTE 2 — For cut panels, smaller sizes and other numbers of imperfections may be agreed upon between the purchaser and the supplier.

\*The total for these sizes of indentations is 3.

†The total for these sizes of indentations is 13.

**7.2.2** The thickness and tolerances do not apply to the outer 25 mm of the trimmed laminated sheet as supplied by the vendor. At least 90 percent of the area, regardless of size, shall be within the tolerances given, and at no point shall the thickness vary from the nominal by a value greater than 125 percent of the specified tolerance.

**7.2.3** For any nominal thickness within the range of nominal thickness 0.5 to 3.2 mm, which is not given in the table of nominal thickness and corresponding deviations, the deviation applicable to the thickness shall be that for the next greater nominal thickness given in the table.

**7.3 Bow and Twist** — The bow and twist requirements are specified in Table 3.

TABLE 3 BOW AND TWIST

( Clause 7.3 )

SL No.	PROPERTY	TEST METHOD [ REF TO CL No. OF IS : 5921 ( PART 1 )- 1983* ]	REQUIREMENT
(1)	(2)	(3)	(4)
i)	Bow	6.6	Shall not exceed the value given by the formula $d ( L / 1\,000 )^2$ mm, where $L$ is the length of the straight edge in millimetres and $d$ is as given in Table 4
ii)	Twist	6.7	Shall not exceed the value given by the formula $d ( L / 1\,000 )^2$ mm, where $L$ is the distance in millimetres between the corner of the sheet not in contact with the horizontal surface and the diagonally opposite corner and $d$ is as given in Table 4

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( *first revision* ).

TABLE 4 PARAMETERS RELATED TO BOW AND TWISTS

( Table 3, Sl No. 1, col 4 )

SL No.	NOMINAL THICKNESS mm	COPPER FOIL ON ONE SIDE, $d$			COPPER FOIL ON BOTH SIDES, $d$
		Bow		Twist	Bow and Twist
		Not over 35 $\mu\text{m}^*$	Over 35 $\mu\text{m}^*$ up to 70 $\mu\text{m}^*$	Not over 70 $\mu\text{m}^*$	Not over 70 $\mu\text{m}$
(1)	(2)	(3)	(4)	(5)	(6)
i)	0.5 to 1.2	55	105	25	25
ii)	Over 1.2 to 1.6	38	75	20	20
iii)	Over 1.6 to 3.2	32	55	15	15

NOTE 1 — Limits for laminates clad with foil of nominal thickness greater than 70  $\mu\text{m}$  ( 610 g/m<sup>2</sup> ), shall be subject to agreement between the purchaser and the supplier.

NOTE 2 — The requirements for bow and twist apply only to sheet sizes as manufactured and to cut pieces having neither length nor width less than 460 mm.

\*35  $\mu\text{m}$  ( 305 g/m<sup>2</sup> ) : 70  $\mu\text{m}$  ( 610 g/m<sup>2</sup> ).

**7.4 Properties Related to the Copper Foil Bond** — These properties are specified in Table 5.

TABLE 5 PROPERTIES OF COPPER FOIL BOND

( Clause 7.4 )

SL No.	PROPERTY	TEST METHOD [ REF TO CL No. OF IS : 5921 ( PART 1 )- 1983* ]	REQUIREMENT
(1)	(2)	(3)	(4)
i)	Pull-off strength	6.11	Not less than 50 N
ii)	Peel strength after heat shock of 10 s by Methods a or b or 5 s by Method c	6.10.4 ( a, b or c )	
iii)	Peel strength after dry heat at 100°C	6.10.5	
iv)	Peel strength after exposure to solvent vapour 1.1.1 trichlorethylene	6.10.6	
NOTE — For solvents other than trichlorethylene, re- quirements shall be agreed upon between the purchaser and the supplier.			
v)	Peel strength after simulated plating	6.10.7	Not less than 0.8 N/mm for copper foil 35 mm ( 305 g/m <sup>2</sup> ) and heavier. Not less than 0.65 N/mm for copper foil 18 mm ( 152 g/m <sup>2</sup> )
vi)	Blistering after 10 s heat shock	6.9	No delamination, no blistering

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( first revision ).

**7.5 Punching and Machining** — Methods of test for punching properties and requirements for these are matters of agreement between the purchaser and the supplier.

## 7.6 Solderability

**7.6.1** When the sheet is tested as specified in 6.8 of IS : 5921 ( Part 1 )-1983\* and in accordance with the times and temperatures specified below, the soldered areas shall be covered with a smooth and bright solder

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( first revision ).

coating. Scattered imperfections, such as pin-holes, shall not occur on more than 5 percent of the surface and shall not be concentrated in one area. At least six specimens out of each batch of ten shall pass the test.

a) *Wetting*

Nominal Thickness mm	Thickness of Copper ( $\mu\text{m}$ )	Maximum Wetting Time (s)	Temperature ( $^{\circ}\text{C}$ )
0.5 up to 1.6	35 ( 305 g/m <sup>2</sup> )	2	235 $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$
Over 1.6 up to 3.2	35 ( 305 g/m <sup>2</sup> )	3	235 $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$
0.5 up to 3.2	70 ( 610 g/m <sup>2</sup> )	3	235 $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$

b) *Dewetting*

Test specimens shall remain in contact with the molten solder for  $5 \begin{smallmatrix} +1 \\ -0 \end{smallmatrix}$  s at  $235 \begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$   $^{\circ}\text{C}$ .

NOTE — For thicknesses of copper greater than 70  $\mu\text{m}$  ( 610 g/m<sup>2</sup> ), the wetting and dewetting times shall be agreed between the purchaser and the supplier.

## 8. NON-ELECTRICAL PROPERTIES OF THE BASE MATERIAL AFTER COMPLETE REMOVAL OF THE COPPER FOIL

**8.1 Appearance of the Base Material** — The base material shall be substantially free from pits, holes, scratches, porosity and resin inclusions and substantially uniform in colour. A small amount of irregular variation of colour is permissible.

**8.2 Flexural Strength** — This test is applicable to sheets not thinner than 1.0 mm of nominal thickness. The test should be carried out in accordance with 7.1 of IS : 5921 ( Part 1 )-1983\*. The flexural strength shall not be less than 7 000 N/cm<sup>2</sup>.

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests. (first revision).

**8.3 Flammability** — The vertical burning test shall be carried out in accordance with 7.2.3 of IS : 5921 ( Part 1 )-1983\*. The following requirements shall be met:

<i>Requirements</i>	<i>Type</i>	
	<i>A</i>	<i>B</i>
Flaming combustion time after each application of the test flame for each test specimen	$\leq 10$ s	$\leq 30$ s
Total flaming combustion time for the ten flame applications for each set of five specimens	$\leq 50$ s	$\leq 250$ s
Glowing combustion time after the second removal of the test flame	$\leq 30$ s	$\leq 60$ s
Flaming or glowing combustion up to the holding clamp	None	None
Dripping flaming particles that ignite the tissue paper	None	None

**8.4 Water Absorption** — It shall be measured in accordance with 7.3 of IS : 5921 ( Part 1 )-1983\* and shall meet the following requirement. In case of thicknesses not included below, the requirement for next greater thickness shall apply:

<i>Nominal Thickness</i>	<i>mg ( Max )</i>
mm	
0.5	50
0.7	50
0.8	50
1.0	52
1.2	55
1.5	60
1.6	60
2.0	65
2.4	70
3.2	80

## 9. PACKAGING

**9.1** The sheets shall be adequately packed and protected in cases or crates to avoid damage in transit and during storage.

\*Specification for metal-clad base materials for printed circuits for use in electronic and telecommunication equipment: Part 1 General requirements and tests ( *first revision* ).

## INTERNATIONAL SYSTEM OF UNITS ( SI UNITS)

### Base Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

### Supplementary Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>
Plane angle	radian	rad
Solid angle	steradian	sr

### Derived Units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Definition</i>
Force	newton	N	$1 \text{ N} = 1 \text{ kg.m/s}^2$
Energy	joule	J	$1 \text{ J} = 1 \text{ N.m}$
Power	watt	W	$1 \text{ W} = 1 \text{ J/s}$
Flux	weber	Wb	$1 \text{ Wb} = 1 \text{ V.s}$
Flux density	tesla	T	$1 \text{ T} = 1 \text{ Wb/m}^2$
Frequency	hertz	Hz	$1 \text{ Hz} = 1 \text{ c/s(s}^{-1}\text{)}$
Electric conductance	siemens	S	$1 \text{ S} = 1 \text{ A/V}$
Electromotive force	volt	V	$1 \text{ V} = 1 \text{ W/A}$
Pressure, stress	pascal	Pa	$1 \text{ Pa} = 1 \text{ N/m}^2$



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